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REVIEW

Multisensory Design in Education: How Architecture Enhances the Learning Experience

Diseño Multisensorial en la Educación: Cómo la Arquitectura Aumenta la Experiencia de Aprendizaje

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ABSTRACT

Introduction: the aim of the article is to explore the existing scientific literature on sensory architectural training in education, establishing an approach to enhance the learning experience and recommending the effective implementation of multisensory architecture in educational settings.
Method: the study used a comprehensive narrative review that consulted databases such as Scopus, Scielo, and Scispace. Specific terms related to architecture and education were used, applying Boolean operators to refine the search. The search period covered from March to April 2024, focusing on articles published between 2020 and 2024. A total of 86 articles were selected, from which 26 relevant articles were selected for the review, after eliminating duplicate articles and those that did not meet the established inclusion criteria.
Results: the results of the review revealed that multisensory architecture in education is essential to positively influence users' emotions and behaviors. It was concluded that educational spaces should be transformed into dynamic environments that stimulate creativity, concentration and learning through sensory stimuli. In addition, it was emphasized that architectural design plays a crucial role in the educational experience, encompassing not only sight but also other senses.
Conclusions: the main conclusions indicate that multisensory architecture transcends the creation of simple structures, transforming spaces into landscapes that encourage exploration, experimentation and learning. It emphasizes the need to empower students through experiences that engage all their senses, thus redefining the educational landscape. Furthermore, it is suggested that the educational experience should be a constant flow of stimuli that awaken curiosity and nurture learning.

Keywords: Multisensory Design; Education; Architecture; Learning Experience.

RESUMEN

Introducción: el objetivo del artículo es explorar la literatura científica existente sobre la formación arquitectónica sensorial en la educación, estableciendo un enfoque para mejorar la experiencia de aprendizaje y recomendar la implementación efectiva de la arquitectura multisensorial en entornos educativos.
Método: el estudio utilizó una revisión narrativa exhaustiva que consultó bases de datos como Scopus, Scielo, y Scispace. Se usaron términos específicos relacionados con la arquitectura y educación, aplicando operadores booleanos para afinar la búsqueda. El período de búsqueda abarcó desde marzo hasta abril de 2024, centrándose en artículos publicados entre 2020 y 2024. Se partió de 86 artículos, de los cuales se seleccionaron 26 relevantes para la revisión, tras eliminar artículos duplicados y aquellos que no cumplían con los criterios de inclusión establecidos.
Resultados: los resultados de la revisión revelaron que la arquitectura multisensorial en educación es esencial para influir de manera positiva en las emociones y comportamientos de los usuarios. Se concluyó que los espacios educativos deben transformarse en entornos dinámicos que estimulen la creatividad, concentración y aprendizaje mediante estímulos sensoriales. Además, se destacó que el diseño arquitectónico tiene un papel crucial en la experiencia educativa, abarcando no solo la vista sino también otros sentidos.
Conclusiones: las principales conclusiones indican que la arquitectura multisensorial trasciende la creación de estructuras simples, transformando los espacios en paisajes que fomentan la exploración, experimentación y aprendizaje. Se enfatiza la necesidad de empoderar a los estudiantes mediante experiencias que involucren todos sus sentidos, redefiniendo así el paisaje educativo. Además, se sugiere que la experiencia educativa debe ser un flujo

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constante de estímulos que despierten la curiosidad y alimenten el aprendizaje.

Palabras clave: Diseño Multisensorial; Educación; Arquitectura; Experiencia de Aprendizaje.

INTRODUCTION

In the vast landscape of contemporary architecture, a fascinating trend is emerging that goes beyond simple aesthetics and functionality, challenging traditional conventions by incorporating a range of sensory experiences into the design of spaces, where different ways of relating the user and spatial design have been sought.[1] For his part, Sánchez-Fúnez[2] notes that in our society, dominated by visual images, architecture has been influenced by sociocentrism, where sight becomes the predominant sense in the development of architectural design (AD). In this regard, Paramita[3] discusses architecture that emphasizes the need for understanding and interaction with sensory stimuli capable of responding to multiple natural qualities through sensory design.

In this context, Bakir et al.[4] propose that AD is for creating spatial processes through sensory experiences that appeal to both the designer's and the user's senses. This makes it essential in education and architectural form to include the sensory senses, referred to as multisensory architecture (MA). It is thus a discipline that seeks to provoke meta-sensory experiences in those who interact with built spaces through emotion and sensation as its two fundamental concepts.

Similarly, Pallasmaa[5] defines that the true richness of architecture lies in its ability to stimulate all our senses, seeking to induce emotions in viewers, transforming the act of inhabiting a space into a holistic and immersive experience from sight, touch, smell, hearing, and beyond. This new architectural frontier has led viewers to observe spaces harmoniously integrated in colors or designs and generate an artistic expression that transcends mere utility. This is why it seeks to express itself through planes of light, textures, flavors, and colors.

Within this framework, Bakir et al.[4] describe that when you walk through a school where AM has been implemented, you find yourself immersed in a world where every detail tells a story, where corridors are not just hallways but paths that guide your senses on a journey of discovery. That is why Helmy-Almaz[6] infers that classrooms are not just teaching spaces but living stages where light dances with shadows and sound whispers secrets of knowledge.

For Sanchez et al.[7], AM goes beyond mere appearance because architecture must evoke emotions and perceptions in those who experience it when walking through these spaces. One can find oneself immersed in a symphony of sensations through the soft caress of tactile materials, the dance of light and shadow playing on surfaces, the evocative aromas floating in the air, and the ambient music accompanying each step because it is not only about what we see but also how we feel when inhabiting a space.

In this perspective, Ramadan et al.[8] define that the evolution of MA in the educational context has been significant, marking a fundamental change in how we design and experience learning environments. At the same time, it has been a continuous process that has developed over time in response to various educational influences and needs, referring again to the fact that educational sensory architecture has become a fundamental approach in the design of learning environments, seeking to optimize the educational experience and integrate sensory stimuli into DA, creating an enriching environment that promotes engagement, exploration, and the personal and academic growth of students.

Within this context, Cattaneo et al.[9] refer to the evolution of educational architecture, which has been a dynamic process that has undergone significant changes over time, influenced by cultural, social, and educational factors. This is because most countries have deep historical roots dating back thousands of years, where the historical role is intertwined with emblematic monuments such as Egypt's pyramids, temples, and tombs. These buildings, places of worship and dwelling places for gods and pharaohs, were also designed to offer unique and meaningful sensory experiences for those who visited them.

Therefore, Helmy-Almaz[6] proposes that due to Egypt's sunny climate, the design of educational spaces should make the most of natural light. Large windows, skylights, and interior courtyards could allow natural light into buildings, creating a bright and healthy environment that improves students' mood and well-being. Similarly, Ahmed-Shaaban et al.[10] recommend the implementation of a sensory architecture for education in Egypt, stating that it could offer an exciting opportunity to enhance the learning experience of students and create more stimulating, inspiring, and culturally meaningful educational environments since, as previously stated, integrating Egypt's rich history and culture would allow for the creation of a unique educational environment that fosters academic success and student well-being.

For their part, Zou M et al.[11] describe how China has an incredible cultural history and educational tradition dating back thousands of years, where MA for education in China often incorporates elements of traditional Chinese architecture, such as interior courtyards, landscaped gardens, and curved roofs that evoke the aesthetics and philosophy of classical Chinese architecture. These elements are visually appealing environments and promote a connection to the country's culture and history. Likewise, Chen[12] argues that AM in China is rapidly evolving to reflect the aspirations of modern Chinese society, which values innovation, sustainability, and connection to culture and tradition by combining advanced technology with sustainable design and cultural elements, where architects are creating environments that enrich people's lives and contribute to sustainable urban development throughout China. These ideas could be adapted to our current constructions and integrated into the educational environment.

In addition, Aldana et al.[13] state that Latin America is reflected in the country's rich cultural heritage, where architects can incorporate traditional architectural elements, such as thatched roofs, adobe walls, and stone textures, to create buildings that respect and celebrate cultural identity and, therefore, these elements not only add a distinctive character to the architectural design but also

evoke a sense of connection to the country's history and culture. Likewise, Ramírez[14] reveals that MA in Peru is emerging as an innovative way of designing spaces that are not only functional but also stimulating and culturally relevant.

Within this framework, this review aims to describe the empirical and conceptual production of multisensory architecture based on empirical references and academic documents to provide an overview of the subject and contribute a tool for future research. Implementing a multisensory approach in our everyday educational environment would provide a spiritual connection to feelings, thus promoting MA and allowing the educational community to understand the deeper meanings hidden behind forms and materials, which go beyond perception.[15] It is crucial to understand the underlying processes of architecture because it not only delights the senses but can also significantly impact the well-being and mood of those who interact with it. Therefore, from creating spaces that encourage relaxation and meditation to environments that stimulate creativity and concentration. Architects need to design in a way that can tangibly influence our emotions and behaviors in any context, especially in a sector such as education, and in turn, stop being a static experience and become a constant flow of stimuli that awaken curiosity and fuel learning. Consequently, multisensory architecture for education is not limited to designing simple structures but, on the contrary, goes beyond art that transforms spaces into dynamic landscapes, where every corner invites exploration, experimentation, and learning, allowing us to perceive beyond the imaginable, redefining the educational landscape and empowering the minds of schoolchildren and young people through an experience that captivates all the senses.

METHOD

Table 1. Results of literature review

Author	Objective	Result
(Pallasmaa, J. et al.[15])	Provide an experiential contribution to art and architecture that involves all the senses simultaneously and stimulates our sense of identity with the experience of the world.	The architectural environments of our time tend to leave us without perception, without the emotional involvement of natural and historical environments.
(Sánchez Fúnez[2])	Convey and demonstrate that architecture can be perceived in our world in relation to history, culture, and nature.	The design of architecture created by a person is capable of fully utilizing all the senses; however, over time, the hegemony of sight has increased.
(Zayats et al.[16])	Demonstrate that the utilitarian elements of construction are an important part of architectural creation.	Architects resort to abstract and unified forms, leaving architectural creativity aside, even though these elements can embellish any building.
(Sanchez et al.[7])	Seek architecture that excites, being more sensory.	It is necessary to establish guidelines in sensory design that allow for the creation of architectural spaces that excite. To do this, spaces that are in contact with nature, capable of activating memories and exciting their occupants by activating the senses, must be studied.
(Martinez-Molina et al.[17])	Conduct a subjective evaluation of thermal comfort with the pedagogical support of teachers based on measurements and questionnaires, both for the educational community.	Provide a roadmap for improving the thermal quality of a building as an important initiative to provide indoor thermal comfort, but the historical significance of the building must be taken into account.
(Ng.[18])	Explore spatial recreation that celebrates local identity as a key driver of architectural production, supported by collaboration between students, architects, and designers.	It has the potential to find a starting point for inclusive architectural education that provides a real, experiential, and engaging learning environment.
(Singh et al.[19])	Draw conclusions about the best ways to advance the challenge of designing teaching and learning spaces.	Renovate existing spaces that need a set of guidelines with independent standards for comfort and design.
(Cattaneo[9])	Reflect on school architecture as a topic for innovation, given that school architecture has become a subject of research and that in recent years there has been a proliferation of work in this field.	The socialization of the study environment enables its collaborative construction and is essential for establishing individual or collective partnerships and advancing networks around school architecture as a subject of study.
(Bianchi[20])	Incorporate knowledge related to sensory aspects in architecture during the development of academic subjects.	Incorporate sensory aspects into the development of the architectural project problem, stimulating creativity and the search for answers, addressing innovative paths through a perfectible method.
(Ramdan et al.[8])	Highlight the importance of the academic identity of architecture schools in strengthening the identity of architecture associated with space and time, through local nature in building materials and construction graphics in architecture.	There is an improvement in resources and an increase in courses in subjects focused on the identity of the approach of modern technologies in construction materials and construction and architecture graphics.
(Bakir et al.[4])	Contribute to the understanding of the relationship between spatial qualities and the multisensory perception of the built environment.	Description of the central environments: tense environment and vibrant environment. Where findings are discussed in relation to the multisensory spatial qualities that have stimulated the senses.

(Galimullina et al.[21])	Interpret the adaptation of school buildings as a developing environment outside of a traditional approach and that design should focus on the learning process itself.	In assessing the accessibility of a school building, several key elements are proposed as fundamental criteria. These elements are identity, acoustic and lighting comfort, proportionality, and clear navigation.
(Pachta[22])	Define the historical, architectural, and construction characteristics of stone schools in the area, as well as detect their state of conservation.	The most thorough evaluation of documentation and identification as heritage structures, in order to convey the tangible and intangible values that are incorporated into future generations.
(Töpper et al.[23])	Show how in larger cities, early one-room schools became multi-room buildings, eventually taking their final form as "large school buildings."	The importance of the academic identity of schools in architecture, the strengthening of identity and architecture associated with space and time in the era of globalization, through nature.
(Helmy Almaz[6])	Describe the importance of studying and analyzing the interior design of educational spaces for students with special abilities and skills that allow them to integrate into society and study the impact of design through sensory perception.	The use of architectural spaces to have the same capacity for understanding by another sense, providing qualified spaces, functionality, and design that the different senses of students can perceive.
(Aldana et al.[13])	Describe the importance of materials for the expression of architecture that must convey sensations as a unique, personal, and intimate experience, which is achieved through a relationship between the individual and the architectural work.	Materiality is important to stimulate the senses because it improves the quality of architecture, where sensory stimulation is the basis for the development of architectural design.
(Chen[12])	Investigate the internal relationship between the evolution of the network of religious buildings and urban development, and characterize the value of religious buildings for the historic city of China.	The protection of religious architectural heritage and the urban characteristics provided by religious factors, emphasizing the use of religious architectural heritage as a potential avenue for cultural and economic regeneration.
(Paramita[3])	Explore the process of measuring, interpreting, tracing, and constructing spatial elements and spatial processes driven by sensory stimuli, promoting different projections of space.	Creating multiple possibilities for sensory design objectives that transcend contexts, practices, and users, significantly expanding the discourse of sensory architecture.
(Córdova Ramírez[14])	Reveal the formal qualities—visually identified on the facades—that influenced the disposition to empathize with the streets, as a first approximation of the complex processes of empathy with the city.	The experience of walking around facades is a multisensory activity that allows us to visually find patterns, which have influenced our understanding of our interaction with the city.
Rosén Rasmussen, Lisa	Explore the changing empirical and theoretical conceptions of the relationship between school architecture, in terms of the architect's pen, and pedagogical architecture.	Reveal deep and meaningful connections that influence the educational experience and the learning environment.
(Kalinkina et al.[24])	Characterize the perception of color and form by children of different ages, considering the specific influence of these means of architectural expression in various spheres of children's activity.	Colors that have a positive effect on children's psycho-emotional state and color combinations that should be avoided have been identified, which determines the percentage of primary and secondary colors in the interior design of educational organizations.
(Ahmed Shaaban et al.[10])	Offer smart city designs that can guarantee the creation of inclusive environments that promote people's well-being.	It demonstrates the latent powers of architectural design through an authentic experiment, highlighting the increase in decisions in physiological and psychological states.
(Shahhoseini et al.[25])	Evaluate how multisensory experiences can affect visitors' "main visuals" through textual and photographic questionnaires.	Urban planners and landscape architects, with regard to the relationship between the senses and its practical implications, promote the main visual ones.
(Li et al.[1])	Establish a macro-meso-micro analysis framework to explore the relationships between sensory experiences and the spatial characteristics of the environment based on big data.	This research went beyond the conventional framework of the five senses to include a sixth sense: interoception, showing that spatial distribution and the relationships between sensory experiences generate a new sense.
(Zou et al.[11])	Identify the sense of place of sacred spaces through the structure, components, material characteristics, and architecture of wooden temples, offering a new perspective that focuses on architectural emotions.	They identified that wooden temples offer not only new emotions towards architectural perspectives, but also perceived their potential to improve people's health and spiritual well-being.

A comprehensive narrative review was conducted to explore the existing scientific literature, consulting the following databases: Scopus, Scielo, and Scispace. To refine the search, the following terms were used: "architecture," "design," "multisensory," "education," "sensory," and "education." In addition, the Boolean operators AND and OR were used to refine and broaden the search scope, and the search period was extended from March to April 2024, considering articles published between 2020 and 2024 for review. This search covered texts written in any language, specifically excluding manuscripts that were case reports,

interviews, letters to the editor, or theses due to their less empirical nature or specific focus. Within the aforementioned databases, 86 articles were initially identified using the search thread designed. Of these, 63 corresponded to the database on multisensory architecture, educational architecture, multisensory in education, emotional architecture, multisensory space for education, history of pedagogical architecture, and sensory architecture in education. Next, two duplicate articles were removed. These are referred to as neuroarchitecture. Subsequently, 23 articles that did not align with the study objective were excluded, along with 12 others that did not meet the established inclusion criteria, including articles more closely associated with psychology. As a result of this filtering and selection process, a final corpus of 26 articles relevant to the review was obtained.

In addition to the results presented, Sánchez[2] reveals that traditional architectural design could engage all the human senses in the spatial experience; however, over time, a trend has emerged toward the primacy of visual perception in the appreciation and conception of architecture, where historically the ability of architecture to stimulate and satisfy multiple senses such as touch, hearing, smell, and taste was valued. Currently, disproportionate attention has been paid to sight, relegating to some extent the importance of the other senses in the architectural experience.

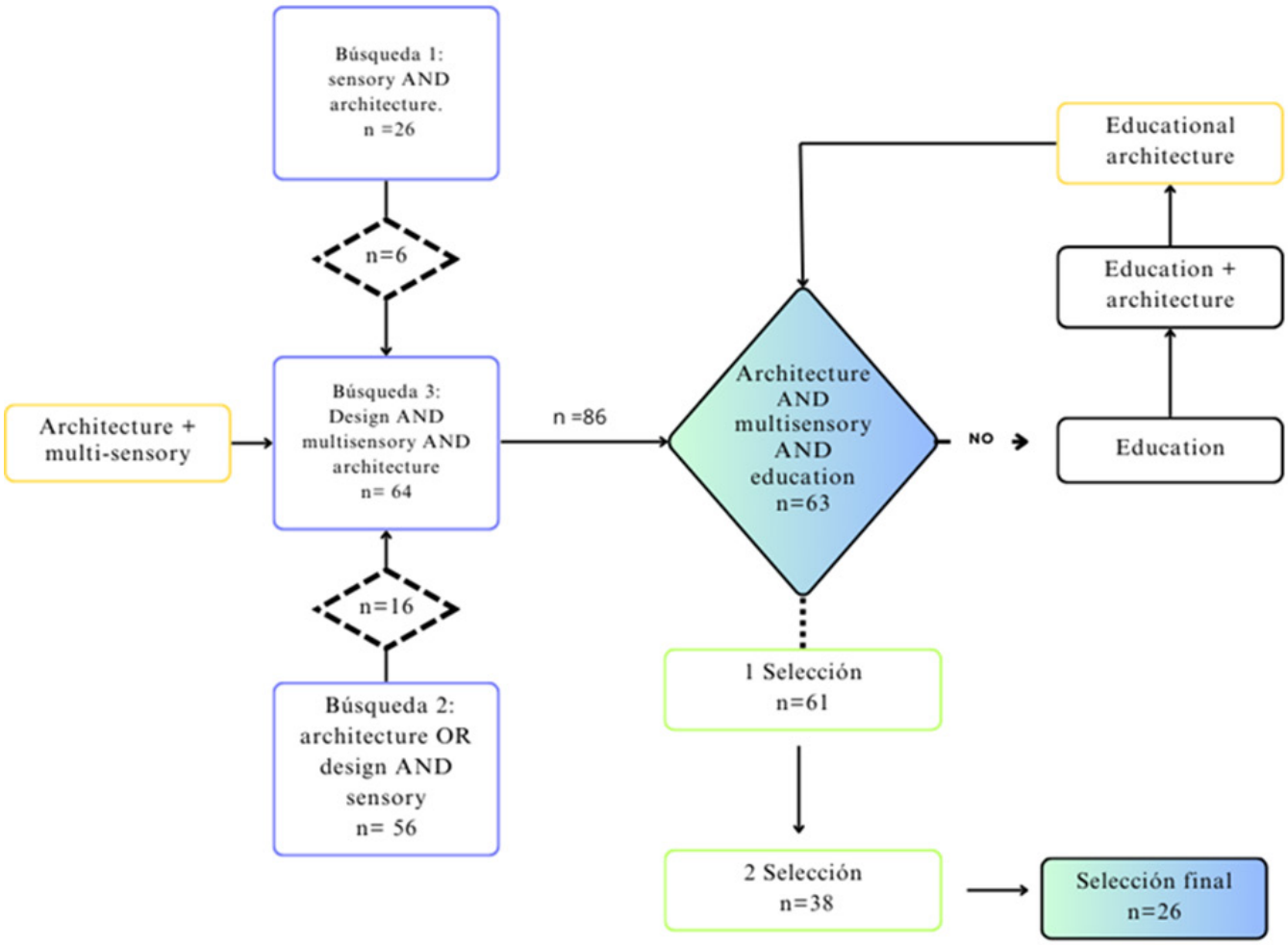

Figure 1. Flow chart of study selection

This review is in line with Shahhoseini et al.[25], who determine the relationship between the human senses and the design of the built environment, which extends to prioritizing the visual, thus implying that when planning and designing urban spaces and landscapes, greater importance is given to visual aesthetics and how environments are perceived through sight. However, this leads to neglecting other important sensory aspects of the experience of space, such as touch, sound, smell, and taste, which could limit the richness and diversity of the urban and landscape experience.

Nevertheless, Sanchez et al.[7] highlight the importance of establishing specific guidelines in architectural design that also allow for the creation of spaces that generate positive emotions in the people who occupy them, as these can evoke deep feelings and emotions in individuals, with the idea that studying in these natural spaces can help us understand how to activate people's memories and emotions through the activation of their senses, such as sight, touch, smell, hearing, and taste. By applying these principles in the design of the environment, places are created that are aesthetically pleasing and generate an emotional connection with their occupants, promoting feelings of well-being, belonging, and joy.

According to Galimullina et al.[21] and Cattaneo et al.[9], the socialization of research on school architecture is essential to enabling collaborative construction in this field, establishing partnerships, and building networks that allow for more effective progress in

research, design, and implementation of solutions in this area.

CONCLUSIONS

Multisensory architecture is not limited to designing simple structures but transforms educational spaces into dynamic landscapes that invite exploration, experimentation, and learning.

Empowering students through sensory experiences that engage all the senses is essential, thereby redefining the educational landscape.

The article highlights that implementing appropriate architectural design can foster creativity, concentration, and learning, turning the educational environment into a constant flow of stimuli.

The importance of considering how architectural design influences users' emotions and behaviors is highlighted, noting that its impact goes beyond the utilitarian function of spaces.

The article emphasizes the need to create inclusive spaces that promote the active participation of students with diverse abilities and perspectives.

It argues that it is crucial to transform the way architecture is conceived in education, moving away from an eye-centric approach to include a broader range of sensory experiences.

The importance of multisensory architecture as a fundamental tool in contemporary education is highlighted. It improves the functionality of spaces and enriches learning experiences.

FINANCING

None.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Juan Alberto Almirón Cuentas, David Hugo Bernedo-Moreira.
Data curation: Juan Alberto Almirón Cuentas, David Hugo Bernedo-Moreira.
Formal analysis: Juan Alberto Almirón Cuentas, David Hugo Bernedo-Moreira.
Drafting - original draft: Juan Alberto Almirón Cuentas, David Hugo Bernedo-Moreira.
Writing - proofreading and editing: Juan Alberto Almirón Cuentas, David Hugo Bernedo-Moreira.

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